Progress on Constellation-X Observation Design Reference Mission

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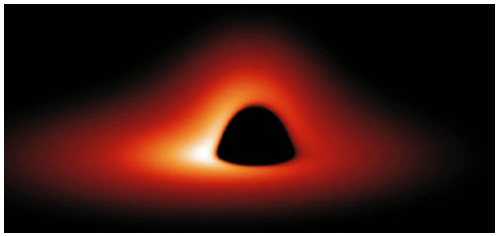
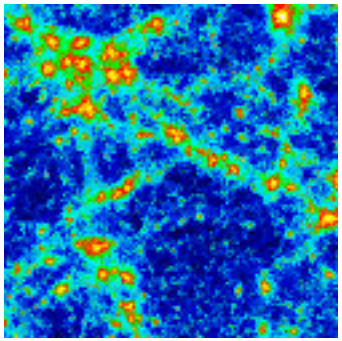
FST meeting: May 7, 2003

Constellation-X Science Objectives



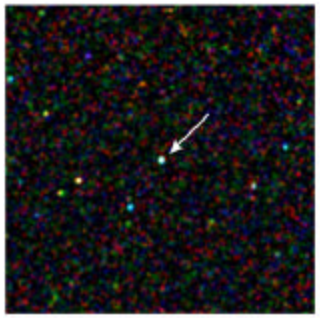
Measure effects of **strong gravity** near the event horizon of black holes.

- What is the nature of space & time?
- What powers supermassive black holes?



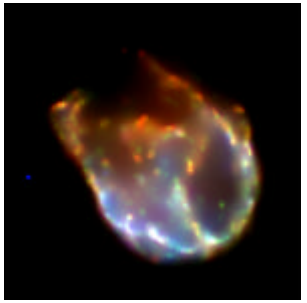
Trace baryonic matter throughout the universe and constrain the nature of **dark matter** & dark energy.

- What is the universe made of?
- How does the universe evolve?



Study formation of supermassive **black holes** and trace their evolution with redshift.

- What roles do they play in galaxy evolution?
- What is the total energy output of the universe?



Study the **life cycles of matter** and energy & understand the behavior of matter in extreme environments.

- What new forms of matter will be discovered?
- How does the chemical composition of the universe evolve?

Observation Design Reference Mission (ODRM)

What is the ODRM?

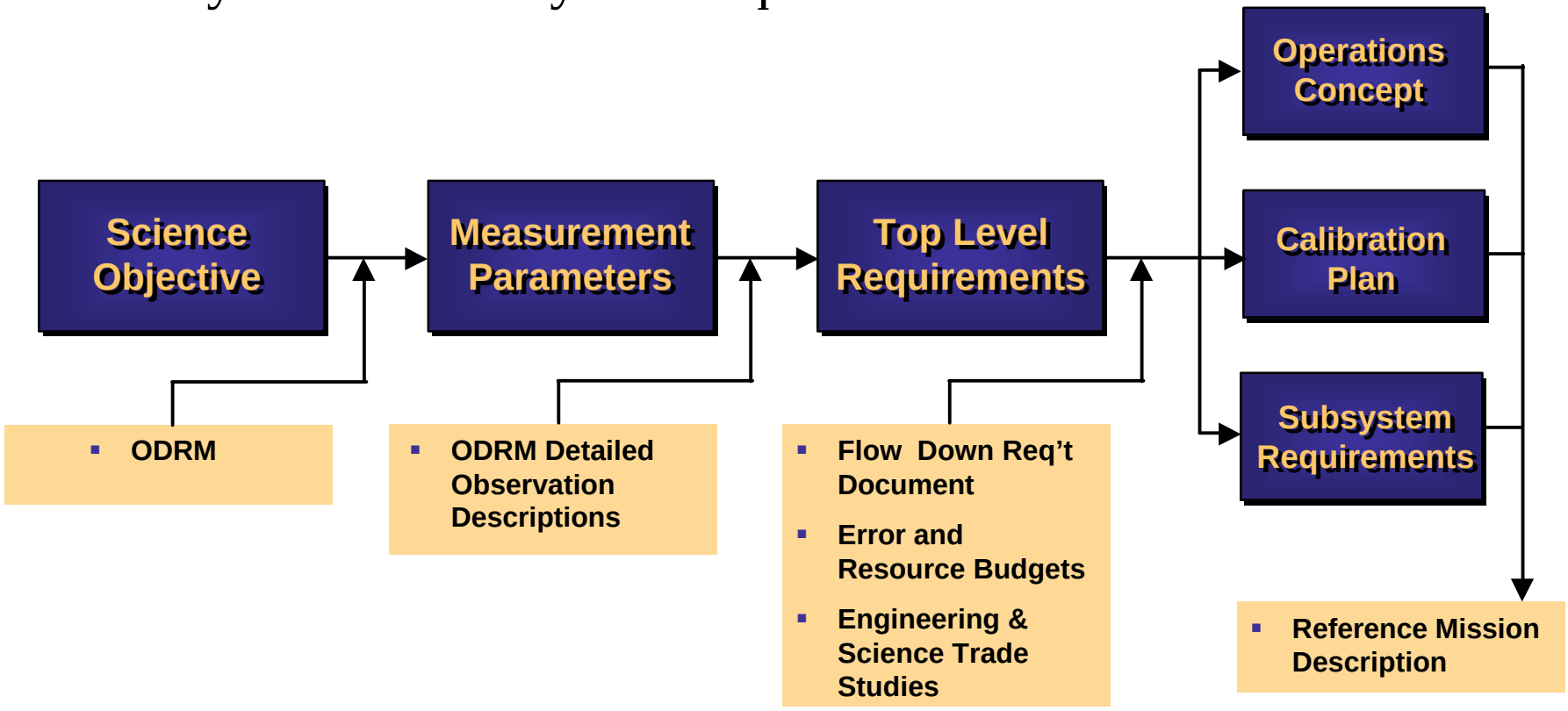
- A scenario for the expected usage of Constellation-X
- Defines science objectives (What are the key General Observer science observations to be made?)
- Produced from informal proposals from science teams that cover the breadth of science

What is it used for?

- Used by industry to evaluate mission design
- Provides starting point for tracing science objectives to measurement parameters
- To derive observatory requirements (number of exposures, data volume, downlink volume, signal to noise requirements)
- To develop calibration requirements
- To pinpoint needed tradeoff studies

Requirements Traceability

- trace science objectives to measurement requirements to system and subsystem requirements



Measurement Parameters

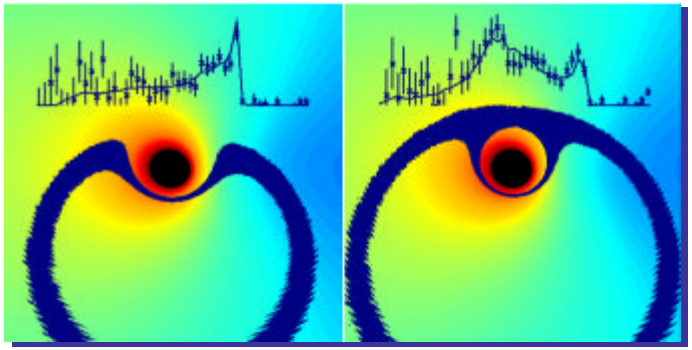
Science Goals Dictate Needed Data Quality

- Category (type) of targets
- Number of unique targets required for science topic
- Number of pointings for each target
- Representative data quality
- Typical exposure time
- Total exposure time for science topic
- Primary data type returned (spectra, images, timing)

Example Requirements Flow Down

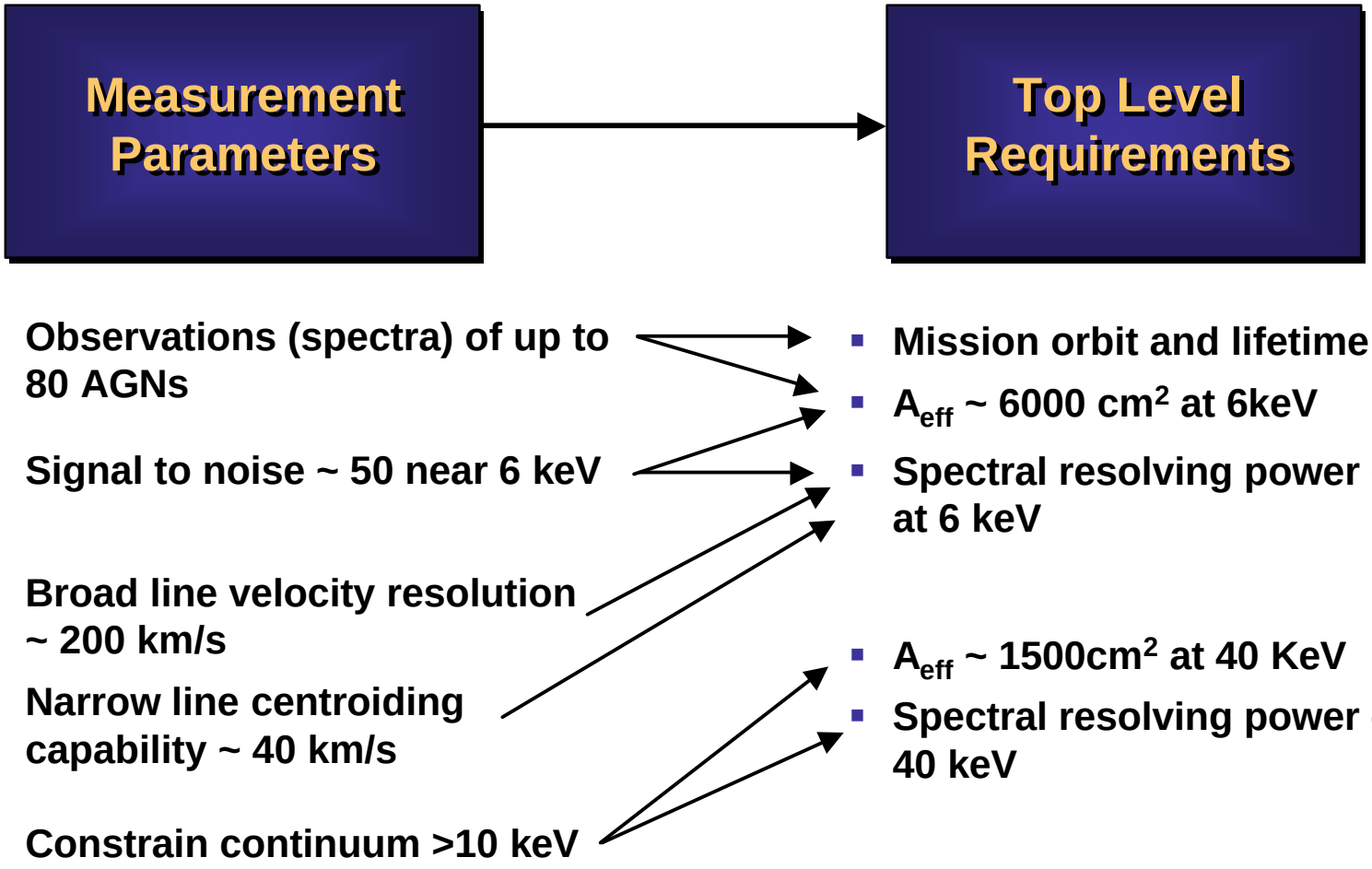
Science Objective → **Measurement Parameters**

- **Measure the effects of strong gravity near the event horizon of supermassive black holes**
  - **Assess validity of GR**
  - **Measure black hole properties**



- **Requires observations (spectra) of:**
  - **AGNs (target category)**
  - **80 targets**
- **Signal to noise ~ 50 near 6 keV**
- **Velocity resolution:**
  - **~ 200 km/s (broad lines)**
  - **~ 40 km/s centroiding (narrow lines)**
- **Constrain the continuum shape near and above 10 keV**

Flow Down cont'



Top-level baseline requirements

- Bandpass – 0.25 to 40 keV (goal 60 keV)
- Resolving power 0.25-6 keV = 300; 6-10 keV = 1,500 (goal 3,000)
- Minimum effective area @ 1.25 keV = 15,000 cm^2
- Angular resolution 15 arcsec HPD below 10 keV (goal 5 arcsec)
- f.o.v <10 keV of 2.5 arcmin (goal 5 arcmin)
- f.o.v >10 keV of 8 arcmin (goal 10 arcmin)
- Timing accuracy 300 microsec (goal of 50 microsec)
- Bright source limit of 10,000 cps/beam/observatory

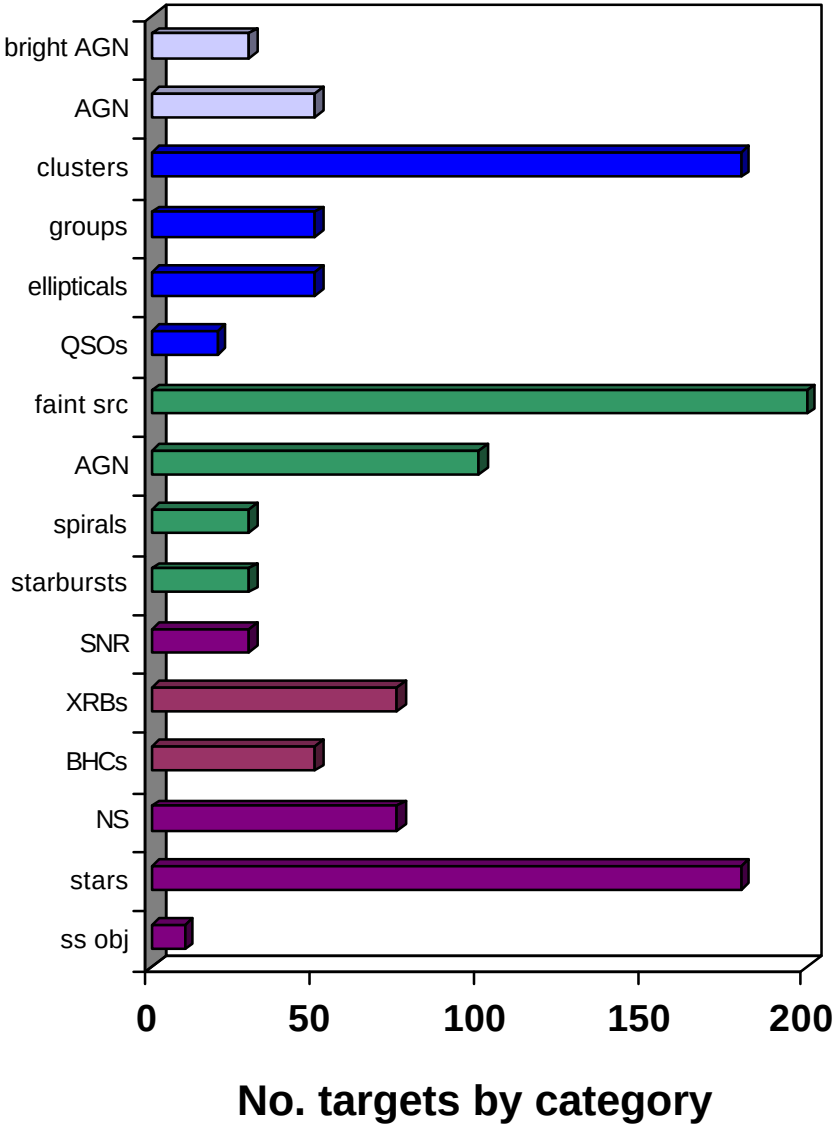
Other

- Wavelength accuracy <20% (goal <10%)
- Photometric accuracy <10% (<5 % goal)
- Relative flux accuracy <5% (<2% goal)
- Celestial location accuracy of 5 arcsec

ODRM Results

Proposals from science teams provide:

- Science justifications
- General observing strategies
  - TOO's
  - Coordinated observations
  - Phase-dependent observations
  - etc.
- Detailed observing scenarios
- Required signal to noise; count rates
- Lists of specific targets
- Calibration requirements



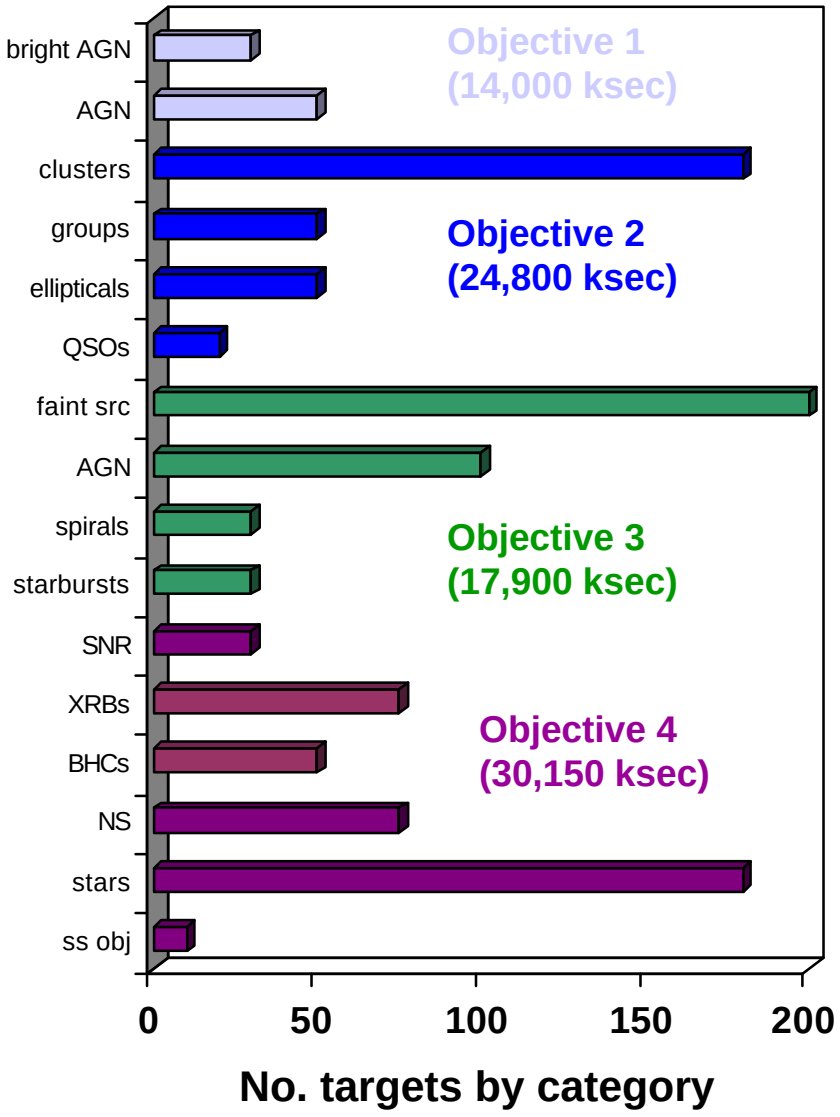
Science objectives:

I. Measure effects of **strong gravity** near the event horizon of black holes.

II. Trace baryonic matter throughout the universe and constrain the nature of **dark matter** & dark energy.

III. Study formation of supermassive **black holes** and trace their evolution with redshift.

IV. Study the **life cycles of matter** and energy & understand the behavior of matter in extreme environments.



Proposals received

- High resolution study of cometary X-ray emission due to charge-exchange (Wolk, Lisse & Christian)
- OB stars in the magellanic clouds: the dependence of hot star X-ray emission on metal abundances (Cassinelli & Waldron)
- X-ray Doppler Imaging of the active binary 44i Boo (Brickhouse)
- Low mass stars in Tr 10 and the Vela OB2 sssociation (Walter)
- X-rays from class I T Tauri stars (Walter)
- Circumstellar absorption in the V471 Tau system (Walter)
- Searching for pulsations from quiescent neutron-star low-mass X-ray binaries (Kaaret)
- Constraining the mass/radius relation of neutron stars in X-ray bursters (Kaaret)
- The photosphere of neutron stars (Walter)
- TOO observations of SNIa (Hughes)
- Kinematics of the Fe-rich ejecta in the SNR DEM 71 (Hughes)

Proposals received cont'

- Multiwavelength obs. of the black hole XTE J1118+480 in quiescence (McClintock)
- The relativistic iron line of GRS 1915+105 (Matt)
- Dark matter distribution in the spiral galaxy NGC 891 (Worrall)
- The effects of extreme gravity: Iron K line reverberation studies (Weaver & Leaman)
- The interaction between the hot gas and radio plasma in Cyg A (Worrall)
- Imaging spectroscopy of soft X-ray emission from clusters of galaxies (Lieu & Mittaz)
- Understanding the warm-hot intergalactic medium (Mathur)

Key science not yet covered

- The Galactic Center
- Extragalactic Populations
- Cluster Cooling Flows
- Star Formation History in the Universe
- Heavily Absorbed AGN and the X-ray Background
- The High Redshift Universe

Original projected dates:

- What science should be examined? *(Aug. – Oct. 2002)*
- What are people's wish lists? *(Sept. – Oct. 2002)*
- Provide new tools/matrices for evaluation *(Oct. – Nov. 2002)*
- Perform science trade off studies and new simulations *(Nov. '02 – Feb. '03)*
- Enlist help of FST & panels *(Aug. '02 – Feb. '03)*

TRIP review !!

New projected dates:

- What science should be examined? *(Oct. '02 – Aug. '03)*
- What are people's wish lists? *(Oct. '02 – Aug. '03)*
- Provide new tools/matrices for evaluation *(June/July 2003)*
- Perform science trade off studies and new simulations *(Aug. '03 – Dec. '03)*
- Enlist help of FST & panels *(Oct. '02 – Dec. '03)*

Possible science trade studies:

- Calorimeter: 4 eV vs. 2 eV resolution @ 6 keV
- Extend low energy range to 0.1 keV
- Extend HXT high energy range to 60 keV
- Goal of 5 arcsec HPD spatial resolution for SXT
- Energy resolution of >1000 at low energies
- 30 arcsec HXT spatial resolution